INTENSIVE EVALUATION AND MONITORING OF CHINOOK SALMON AND STEELHEAD TROUT PRODUCTION, CROOKED RIVER AND UPPER SALMON RIVER SITES

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INTRODUCTION

In 1986, a BPA-funded project was begun by IDFG to intensively evaluate the smolt production from two important anadromous rearing streams. The main objective of this study is to determine suitable methods to accurately enumerate smolt production, and intensively evaluate smolt production from these two streams. The streams selected for this study are the upper Salmon River above the Sawtooth Hatchery, and the Crooked River, which is a tributary to the South Fork Clearwater River. Methods to be used in this study include downstream migrant trapping with inclined screen traps, and tagging with passive integrated transponder (PIT) tags.

The Snake River Basin within Idaho, including the Salmon, Clearwater, and upper Snake River drainages, historically produced an estimated 40% of the total spring chinook salmon, 45% of the total summer chinook salmon, and 55% of the total summer steelhead trout in the Columbia River Basin. Substantial numbers of sockeye and fall chinook, and lesser numbers of coho salmon, were also produced (Idaho Department of Fish and Game (IDFG) 1985).

This vast anadromous fish resource supported an extensive Native American harvest for thousands of years with no apparent deleterious effects on the resource. With the arrival of European settlers to Idaho in the 1800s, there soon developed non-Indian commercial, subsistence, and sport fisheries for this anadromous fish resource. As Idaho became more developed in the 1900s, the populations of anadromous fish began to decline. By the mid-1970s, naturally produced stocks of salmon and steelhead appeared to be headed towards extinction in Idaho, and the hatchery-produced anadromous fish were not faring much better (IDFG 1985).

The depressed condition of the stocks of anadromous fish in Idaho is a result of many interrelated factors, including: hydroelectric dams, irrigation diversions, logging, road building, mining, stream channelization, livestock grazing, and excessive harvest.

Of all the factors contributing to the decline of anadromous fish stocks in Idaho, hydroelectric dams have been the most damaging (Mallet 1974). Hydroelectric dams block access to approximately 50% of the anadromous spawning and rearing habitat in Idaho, cause high mortalities of migrating fish, and reduce stream flows during critical migration periods.

The Bonneville Power Administration (BPA) has begun efforts to mitigate for the losses to anadromous fishes caused by the hydroelectric dams on the lower Snake and Columbia rivers. To maximize the effectiveness of their efforts, BPA has been working jointly with the agencies responsible for managing anadromous fish in the Columbia River Drainage. The five-year (1985 to 1990) IDFG Anadromous Fish Management Plan is being used as a guideline for mitigation efforts in Idaho. This plan lays the groundwork to restore, enhance, and manage Idaho's anadromous fish resources; and establishes smolt production goals by river basin and subbasins.

One type of mitigation that BPA has begun is stream habitat enhancement projects, which are intended to either increase the amount of habitat through barrier removal, increase the carrying capacity of existing degraded habitat, or both. These stream enhancement projects are not only being conducted in the Columbia Basin with BPA funds, but are being funded by other agencies that are conducting studies throughout the North American range of Pacific anadromous salmonids.

Most researchers in this field agree that accurate estimates of smolt Production by discharge would be the best data to evaluate these stream enhancement projects especially for wild-natural fish (Buell 1986). However, developing methodologies to accurately determine smolt production is physically difficult in most anadromous rearing streams because the smolts migrate during the spring period of high flows. Another complication to estimating smolt production in high mountain streams (much of the anadromous habitat in Idaho) is that most of the parr will move downstream to larger mainstream pools to overwinter before their smolt migration in the spring.

STUDY SITES

Upper Salmon River

The Salmon River originates in the Sawtooth, Smokey, and White Cloud mountains in south central Idaho. The upper Salmon River study site is located upstream from Sawtooth Hatchery at elevations above 6,500 feet. Study transects will be located throughout the upper basin (Fig. 1). This upper river is a major production area for spring chinook salmon and also produces significant numbers of summer steelhead trout. Resident salmonids in the upper Salmon River Drainage are native rainbow trout, cutthroat trout, bull trout, mountain whitefish, and non-native brook trout (Mallet 1974).

Historically, sockeye salmon runs existed in all moraine lakes in the Stanley Basin (Everman 1895). A remnant run of sockeye rears in Redfish Lake, which is located approximately two river miles downstream from Sawtooth Hatchery. Adult sockeye are still occasionally seen in Alturas Lake Creek (K. Ball, IDFG, personal communication), but an irrigation diversion that completely dewaters the creek every summer makes adult passage to the lake very unlikely (Bowles and Cochnauer 1984). No other sockeye runs are now known to exist in the Salmon River Drainage, except the remnant run to Redfish Lake.

High water quality and an abundance of high-quality spawning gravel are present throughout the upper basin. Rearing habitat, however, is less abundant. Typical water flows in the Salmon River at Sawtooth Hatchery range from lows of 200. to 400 cfs from midsummer through early spring to highs of 1,300 to 2,700 cfs during late spring and early summer. Flows are regularly diverted from the upper Salmon River, and some of its tributaries for irrigation of the upper basin. Between Alturas Lake Creek and Pole Creek, an irrigation diversion completely dewaters the river for

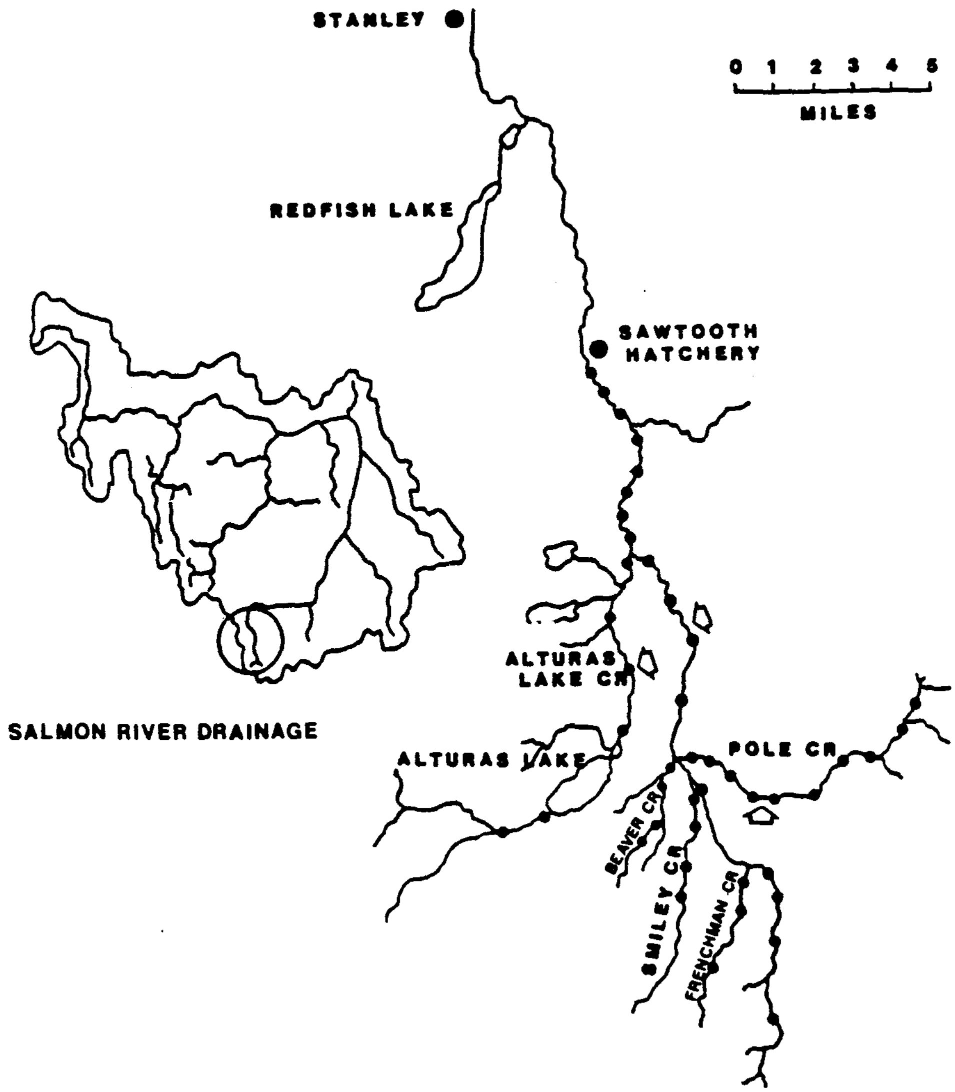

Figure 1. Location of the upper Salmon River study site and transects (•). Arrows indicate irrigation diversions.

one-quarter mile during the summer. Flow diversions from tributary streams vary from only partial to complete dewatering. A change from flood irrigation to overhead sprinklers has decreased the use of water from Pole Creek significantly since 1982. Steelhead were reintroduced into Pole Creek in 1985 (C. Petrosky, IDFG, personal communication).

Livestock grazing and growing hay or pasture are predominant uses of private land throughout the upper Salmon River Basin. Water diversions from the river and tributaries, in addition to grazing in riparian zones, have somewhat degraded aquatic is habitat, and impaired the potential for production of salmon and steelhead in the upper Salmon River Drainage.

A broodstock development program has been operated at Sawtooth Hatchery by IDFG since 1984. The hatchery was constructed by the U.S. Fish and Wildlife Service (USFWS) through the Lower Snake River Compensation Plan. The hatchery program involves trapping of adult salmon and steelhead, and release of smolts. Projected chinook smolt production is 2.4 million per year. Eyed steelhead eggs are sent to other facilities for rearing, and the smolts are transported back to Sawtooth Hatchery for release. Approximately 700,000 steelhead smolts were released from the hatchery in 1986 (T. Rogers, IDFG, personal communication). A release of 1.5 million per year has been recommended by K. Ball (IDFG, personal communication). Approximately 33% of each year's adult run of each species is allowed to migrate upstream of the hatchery to spawn naturally.

Crooked River

Crooked River originates at an elevation of 6,800 feet in the Clearwater Mountains within the Nez Perce National Forest, and enters the South Fork Clearwater River at river mile 58.4 at an elevation of 3,750 feet (Fig. 2). The entire Crooked River Drainage is included in the study site. Salmon and steelhead runs were eliminated by construction of Harpster Dam on the South Fork Clearwater River in 1927. Spring chinook and summer steelhead were reestablished in Crooked River following removal of the dam in 1962. Resident salmonids in Crooked River include mountain whitefish, rainbow trout, bull trout, and cutthroat trout (Fishery Assistance Office, USFWS, Ahsahka, Idaho, unpublished data).

Snorkel surveys were conducted in 1984 by IDFG and the Intermountain Forest and Range Experiment Station, USFS, Boise, Idaho (Petrosky and Holubetz 1985). They found that densities of juvenile chinook and steelhead in the two meadow reaches were relatively lower compared with those in other Idaho streams. Densities of fish in pools were not much higher than in high-velocity sections. This lack of an apparent relationship between juvenile densities and habitat quality indicated underseeding in the upper meadow in 1984.

Idaho Department of Fish and Game (1985) identified Crooked River as having high water quality and habitat potential for production of salmon and steelhead. Dredge mining activities during the 1950s rechannelized much of Crooked River and severely degraded habitat within the two meadow reaches of the stream. The stream has been forced to the outside of the

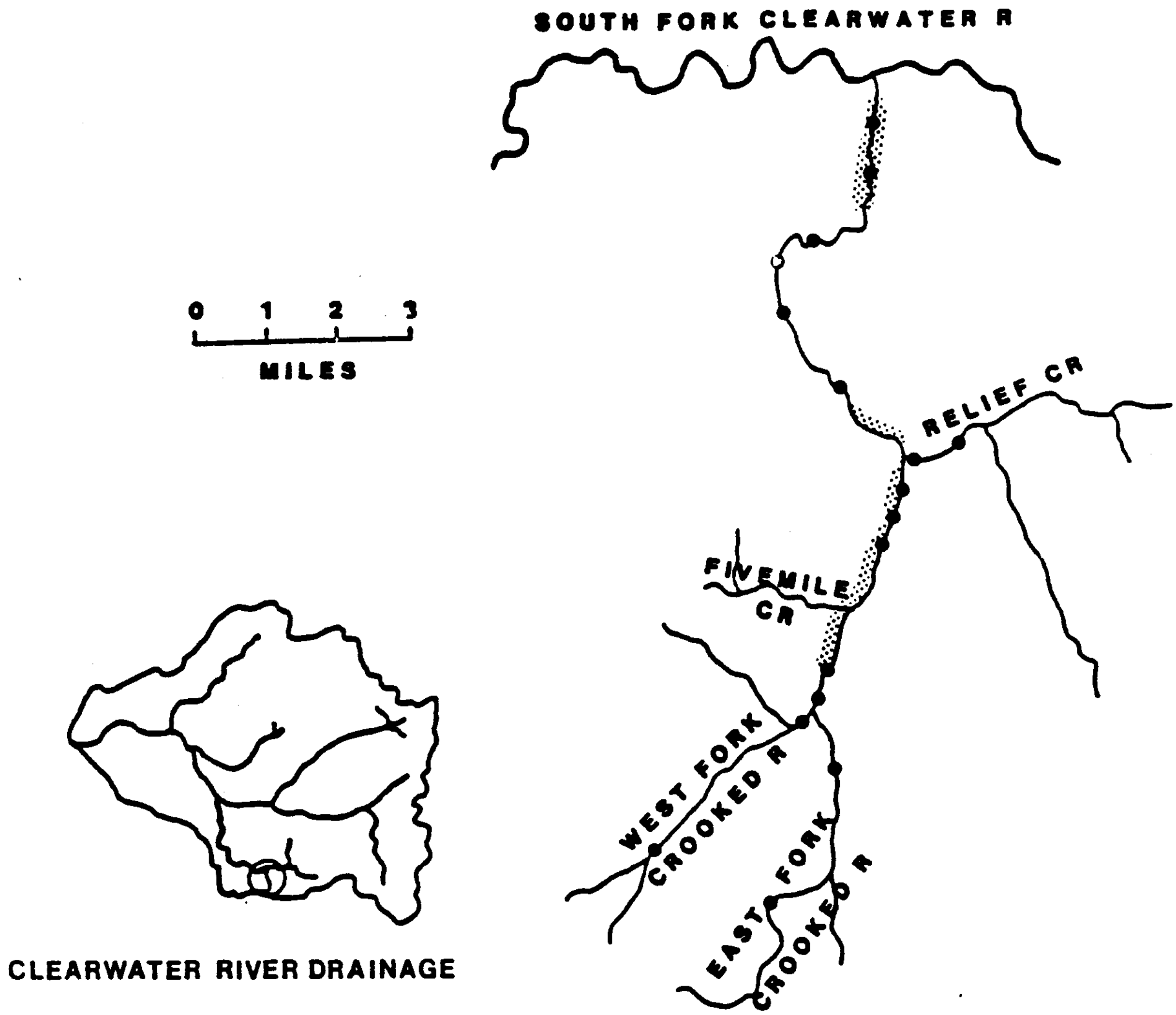

Figure 2. Location of Crooked River, with meadows (shaded) degraded by dredging, and transect locations (•).

upstream meadow, resulting in a steep, straight channel. Dredge tailings throughout the lower meadow have formed long meanders with many ponds and sloughs. During runoff, juvenile trout and salmon use some of these ponds, and are trapped as flow recedes.

In 1984, the U.S. Forest Service, with BPA funds, placed a series of log structures, rock and boulder reflectors, organic debris structures, and loose rock weirs within the upper meadow in an effort to lower the stream gradient and increase the pool to riffle ratio. In addition, banks were stabilzed and revegetated, an off-channel pond was connected with a side channel, and a culvert that blocked adult passage was removed (Hair and Stowell 1986).

MATERIALS AND METHODS

Habitat Evaluations and Fish Densities

Habitat and fish density surveys have been conducted in both the upper Salmon River Basin and Crooked River by the IDFG (Petrosky and Holubetz 1985 and 1986). We will evaluate habitat and estimate fish densities at sites that were used by Petrosky and Holubetz in 1984, 1985, and 1986, which will allow us to incorporate their data into our evaluation efforts. Additional transects may be created if deemed necessary to adequately evaluate the two drainage basins. Stream habitat evaluation methodology will follow Petrosky and Holubetz' (1985) modifications of methods derived by Platts et al. (1983).

Petrosky and Holubetz established evenly spaced 10 m transects within a selected stream reach to evaluate habitat. Stream width will be measured at each transect. The following measurements will be made at locations one-quarter, one-half, and three-quarters of the stream width at each transect: depth, velocity, substrate composition and embeddedness, and habitat type (i.e., pool, run, riffle, pocketwater, or backwater). Proportions of sand (<0.2 inch diameter), gravel (0.2 to 2.9 inch), rubble (3.0 to 11.9 inch), and boulder (>12 inch) that comprise the substrate will be estimated ocularly. The criteria for substrate embeddedness measures will be the proportion of surface area of gravel, rubble, and boulder that is surrounded by finer sediment. Embeddedness will be classified as <5%, 5 to 25%, 25 to 50%, 50 to 75%, and >75%. All transects will be marked for future repeated measurements.

Fish abundance by species and length class will be estimated by snorkeling a known stream distance through habitat transects. Petrosky and Holubetz (1985 and 1986) found snorkeling to be an effective method of enumerating fish at both study sites. Observations made by snorkeling can be superior to other methods of enumerating salmonids and determining habitat preferences (Goldstein 1978; Platts et al. 1983). Trout and salmon tend to hold their position in the presence of an underwater observer, but electrofishing and seining operations disturb and chase fish out of habitat they have selected.

Tagging and Tag Monitoring

Individual PIT tags will be implanted in up to 2,000 each of juvenile chinook and steelhead in the upper Salmon River Drainage during August, 1987. Fish will be collected with electrofishing gear, or seines, and anesthetized with MS-222. PIT tags will be injected into the body cavity using a 12 gauge hypodermic needle, and a modified syringe. Length and weight data will be taken on fish that are tagged. Fish will be held in fresh water until fully recovered, and then released back into the stream. Each PIT tag transmits a unique 10 digit alphanumeric code when it is energized by a radio frequency pulse emitted by the detector. In the field, hand-held PIT tag detectors will be used that can store over 1,300 tag codes, or send the codes directly into a portable computer.

A large proportion of juvenile chinook and steelhead are believed to move downstream out of higher elevation primary nursery streams to overwinter. A downstream migrant trap will be placed at the Sawtooth Hatchery adult collection weir to monitor movement of these fish. This trap will be attended from the time that it is installed until fall migration ceases. All fish captured in the downstream migrant trap will be scanned with a hand-held detector to identify previously PIT-tagged fish. Up to an additional 1,000 each of chinook and steelhead will be tagged at the trap, and then released downstream.

DISCUSSION

Since work began on this project by IDFG in September, 1986, the first seven months were spent primarily on researching methodologies to be used, and project planning. The two major methodologies that needed to be developed were how to trap downstream migrating salmonids in high mountain streams, and what type of tag, or mark, to be used.

A major effort was put into corresponding and meeting with other researchers who have conducted trapping studies on downstream migrating salmonids. After these initial contacts, the IDFG personnel working on this project began a series of meetings to design a downstream migrant fish trap to the upper Salmon River study site. Early in these meetings, it was decided to attach the trap to the back of the existing adult collection weir for Sawtooth Hatchery. Attaching the trap to this location will have the following advantages: a solid support structure for attachment, protection from large debris, some guidance of migratory steelhead juveniles, and a well-equipped IDFG facility nearby.

The developed trap design calls for trapping all the fish passing through one of the 10 foot embayments on the side of the weir away from the adult collection facility. This embayment was selected so that juvenile trapping would not interfere with adult collection, and because the thalweg passes through this embayment. Because the trap will not allow returning adults to challenge the weir in this embayment, we will replace the standard 1.125 inch gap trashrack with one having 2.25 inch gaps. Reports of steelhead juveniles working back and forth along a weir with standard trashracks before passing through leads us to believe that they will preferentially pass through a trashrack with 2.25 inch spacing, thereby increasing our trapping efficiency. The 1 foot drop in water level that exists at the weir will be utilized to increase water velocity to allow 4 inches of water to flow over the top of the inclined screen and still have a sufficient drop in water level to hold fish in the live box. The trap is also designed so that when the hatchery manager decides to pull the trashrack due to high water, the trap can be removed within two hours.

Because construction on the IDFG-designed trap could not begin until late in the 1987 sampling season, it was decided to purchase two modified Humphry scoop traps. One of these traps will be used during the fall of 1987 and the spring of 1988 at the Sawtooth Hatchery weir with the same set-up planned as the IDFG-designed trap. Starting in the fall of 1988, the IDFG-designed trap will be used at the Sawtooth Hatchery weir, and the modified Humphry scoop trap will be used in Crooked River. The other modified Humphry scoop trap will be used as a backup, and possibly to trap in one of the larger upper Salmon River tributaries.

The fish tag selected for this project is the passive integrated transponder (PIT) tag developed by Identification Devices, Inc., and tested for applicability in fisheries research by the National Marine Fisheries Service (NMFS). NMFS studies have shown the glass encapsulated PIT tag is highly reliable in tagging fish as small as 3 g (65 mm). The tag retention rate is higher than 99% (Prentice et al. 1986).

PIT tags have a virtually unlimited life span because they contain no batteries. The energy to transmit the tag codes is supplied by a radio frequency pulse emitted by the detector system. One advantage to using PIT tags is the capability of hand-held detectors to decode them. These detectors store over 1,300 tag codes, or send the codes directly into a portable computer. To detect the tag, the activated hand-held detector is merely passed over the fish.

Tests by NMFS have shown that tagged smolts can be automatically recognized at a rate of 97 to 100% by detection and recording devices located within the smolt collection facilities at Lower Granite, Little Goose, and McNary dams. With information being collected for each individual fish, and with detection of virtually all the tagged smolts passing through the bypass system at these dams, NMFS has estimated that only 5 to 10% of the number of fish are needed to collect statistically valid information as in studies using traditional tags or marks. This will be extremely useful in our research on wild-natural anadromous fish populations where the large number of fish necessary for other tagging methods are not easily obtainable.

The types of information that PIT tags can provide include: parr-to-smolt survival, smolt-to-adult survival, migration survival, migration timing, and production areas. Because data is gathered from individual fish, the information listed above can be correlated with such variables as length, weight, condition, stock, method of hatchery supplementation, etc.

During the 1988 fiscal year (July 1987 to June 1988), project efforts will be concentrated on the upper Salmon River site where downstream migrant trapping and PIT tagging technologies will be tested for their effectiveness in meeting objectives. Physical habitat surveys, parr density estimates, and chinook salmon redd counts will begin at both the upper Salmon River and Crooked River sites.

Standing crop estimates of fish and physical habitat evaluations will be conducted in July, August, and September. PIT tags will be implanted in wild-natural juvenile salmon and steelhead collected in the upper Salmon River study area in August, 1987.

The downstream migrant trap will be installed in the Salmon River as early as feasible, and will be tested until downstream movement of fish ceases. The trap will be reinstalled in early March, 1988, and the spring outmigration will be sampled.

Winter months will be devoted to data analysis, report writing, and participating in agency and interagency meetings to discuss the progress of this and related projects.

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APPENDIX

PIT TAG TECHNICAL INFORMATION

The passive integrated transponder (PIT) tag was developed by Identification Devices, Inc., of Denver, Colorado, and tested for applicability in fisheries research by the National Marine Fisheries Service (NMFS). The PIT tag is a silicon computer chip and a copper antenna encapsulated in a glass cylinder 10 mm long and 2.1 mm in diameter. The tag is smooth, leak-proof, and biologically inert.

The energy to operate the PIT tag is supplied by a radio frequency pulse that is produced by the detection system. When a tagged fish passes through this radio frequency pulse, the microprocessor chip in the tag is energized by electromagnetic field. The energized microprocessor chip then transmits its unique 10 digit alphanumeric code, which is received and decoded by the detection system. The 10 digit alphanumeric code system provides about 32 billion possible code combinations. The PIT tag is passive until energized by a detector; and for all practical purposes, it has an unlimited life span and can be recycled.

NMFS studies have found the glass encapsulated version of the PIT tag highly reliable in tagging fish as small as 3 g (65 mm) with a tag retention rate of higher than 99% (Prentice et al. 1986). To implant the PIT tag, a 12 gauge needle and modified hypodermic syringe are used to inject the tag into the peritoneal cavity of the fish. On juvenile fish, the tag is inserted just off the midventral line about one-quarter of the distance between the end of the pectoral fin and the pelvic girdle. Immediately after the needle enters the body cavity, the needle angle is changed so that the needle is in contact with the inner surface of the body wall, and the tag is implanted. After tagging, tag presence can be confirmed using a hand-held detection and decoding device. Of the few fish that die due to perforated organs during tag implantation, almost all will show behavioral changes, and/or darkening of color almost immediately after tagging. NMFS has found that once a functional tag has been successfully implanted in a fish, the tag failure rate has been O%.

There are three different basic detector systems being used with PIT tags. The first is a small 6 inch square detector used to send a tagged fish's identification code directly to a computer data collection system during a large-scaled tagging operation, such as those at a hatchery. The second is a hand-held detector primarily used in the field. The hand-held detector sounds a tone when a reading is completed, and displays the code on a liquid crystal display until it is reset. The hand-held detector can store over 1,300 tag codes, or it can feed the codes directly into a computer. The third detector system, which is installable at fish ladders, weirs, smolt.bypass systems, or other sites, is a series of 18 inch maximum diameter pipes with detector loops built in. This system is automatic and interfaces with a computer on-site that is connected to a power interruption protection unit. This latter type of detector system is installed in the smolt bypass systems at Lower Granite, Little Goose, and McNary dams. Plans have been made to have detection systems operating in the adult fish ladders on several of the Columbia Basin dams in the next several years.

Tests by NMFS have shown that tagged smolts can be automatically recognized at a rate of 97 to 100% by detection and recording devices located within the smolt collection facilities at hydroelectric dams. With information being collected for each individual fish, and with detection of virtually all the tagged smolts passing through the bypass system, NMFS has estimated that only 5 to 10% of the traditional number of tagged or marked fish are needed to collect statistically valid information (Prentice et al. 1986).

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